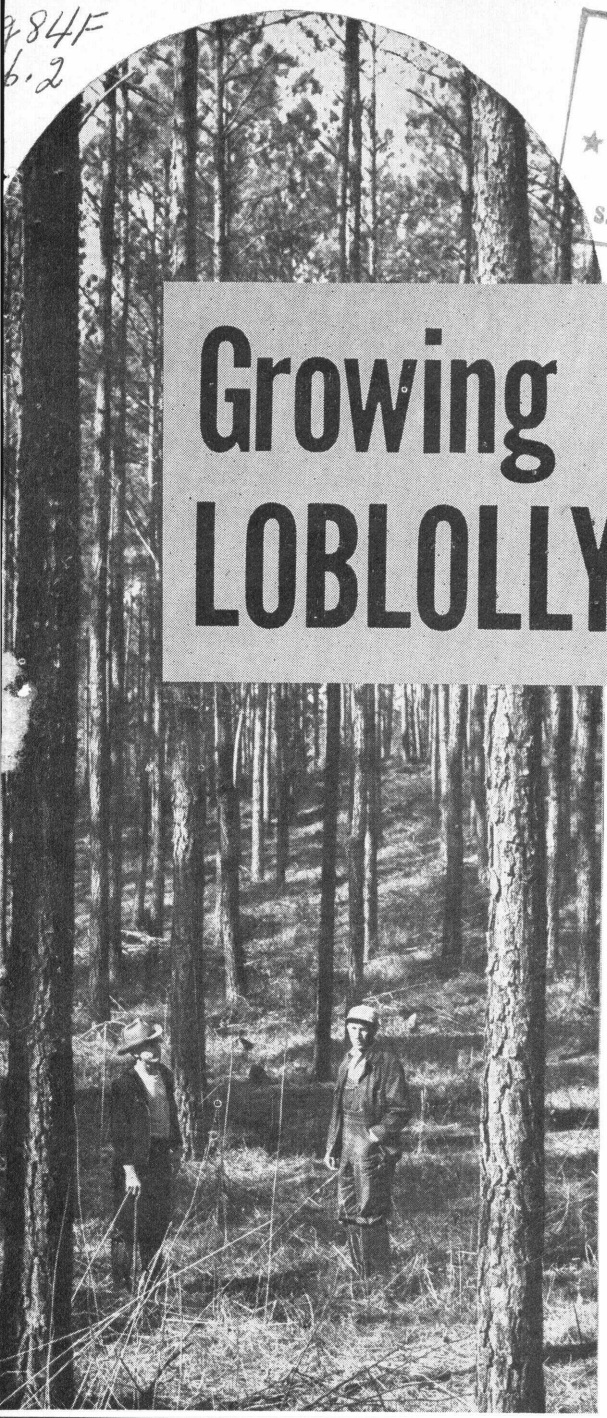

Growing LOBLOLLY PINE

in the SOUTH ATLANTIC STATES

FARMERS' BULLETIN NO. 2097

U. S. DEPARTMENT OF AGRICULTURE

DURING the past 20 years many thousands of acres of loblolly pine land have been purchased by private investors who want to grow trees as a crop. Much of this acquisition has been by forest industry and by small investors—farmers and city folk. Generally, the industrial holdings are managed by competent foresters. On the other hand, small owners need information on managing their woodlands. Thousands of acres of loblolly have been planted. It is the purpose of this publication to give clear directions for handling loblolly pine as a paying crop from seed to final harvest.

Loblolly pine grows over a larger area and under a wider variety of conditions than any of the other Southern pines. It becomes difficult, therefore, to establish basic recommendations that can be applied over the entire range of loblolly pine. The information and recommendations contained in this bulletin apply directly to the South Atlantic States of Virginia, North Carolina, South Carolina, and Georgia, and to a lesser extent elsewhere.

This bulletin supersedes Farmers' Bulletin 1517, Loblolly Pine Primer.

Washington, D. C. **FEBRUARY 1956**

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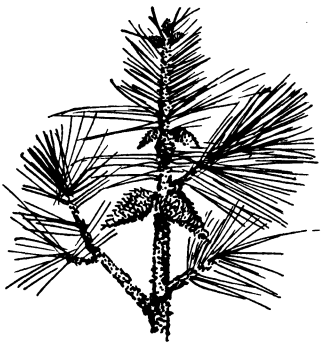

By Thomas Lotti
Southeastern Forest Experiment Station, Forest Service

THE TREE AND WHERE IT GROWS

What Is Loblolly Pine

Loblolly pine is one of the most valuable trees in the South. It grows to large size faster than any of the other Southern pines.

Loblolly pine is easy to recognize. The needles are 6 to 9 inches long, growing in clusters of 3 (occasionally 2). Its cones are usually 3 to 5 inches long, having short, sharp spines. On young trees the bark is nearly black and scaly; on older trees it is 1 to 2 inches thick and divided into irregular dark-brown, scaly blocks. Mature trees are generally 80 to 100 feet high, having a tall, straight trunk, with larger specimens averaging about 2 feet in diameter (fig. 1). Branches are short, thick and much divided, the lower branches spreading and the upper ascending and forming a compact round-topped head. In various localities the tree is also known as North Carolina pine, old-field pine, southern pine, or shortleaf pine. However, it should not be confused with the true shortleaf with which it often grows. At the same age loblolly is generally larger, with heavier and longer branches, and has longer needles and much larger cones than shortleaf pine.

Where Does It Grow

Loblolly pine grows naturally over a large territory. From a point on the Atlantic coast near Washington, D. C., the loblolly belt swings southwest in a broadening crescent for a distance of nearly 1,500 miles, crossing the Mississippi River and extending into Arkansas and Texas (fig. 2). At the northern end of its geographic range the species is confined to the flat Coastal Plain. Farther south, longleaf and slash pine take over the Coastal Plain, and loblolly pine is found on the rolling lands of the interior. It occurs in all the South Atlantic States, being most prominent in southeastern Virginia, the eastern third of North Carolina, the eastern half of South Carolina, and the middle part of Georgia. The tree grows in pure stands or in mixtures with other pines and hardwoods on a wide variety of sites, being particularly aggressive on old fields and cutover areas. It also occurs as a single tree or in small groups in association with hardwoods on moist situations and along streams.

How Fast Does It Grow

From early age loblolly pine is faster growing than either longleaf or true shortleaf pine. During the first 20 years or so, slash pine within its natural range may grow faster; but beyond that, and up to about 80 years, loblolly exceeds all of the other southern pines. Although pulpwood sizes are attained on the average in about 25 years, commercial thinnings have been made on the best sites as early as 7

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Figure 1.—Mature stand of loblolly pine in coastal North Carolina.

years, and frequently at 10 to 16 years. Small sawtimber can be raised on average sites in 40 years, and larger sawtimber in 65 years.

What Are Its Uses

In 1951, almost 45 percent of the 4.6 billion board-feet of softwood lumber produced in the South Atlantic States was loblolly pine (fig. 3). That same year the species comprised about 40 percent of 5.4 million cords of pine cut for pulpwood in the area. Sawlogs are usually cut from trees over 10 inches in diameter.[1] Pulpwood is cut mainly from smaller trees and, in increasing amounts, from the tops of trees that have been felled for sawtimber. Poles and piling are also cut from loblolly pine, usually requiring the

[1] Tree diameter, unless otherwise specified, is that measured at a point 4½ feet from ground (diameter at breast height or d. b. h.).

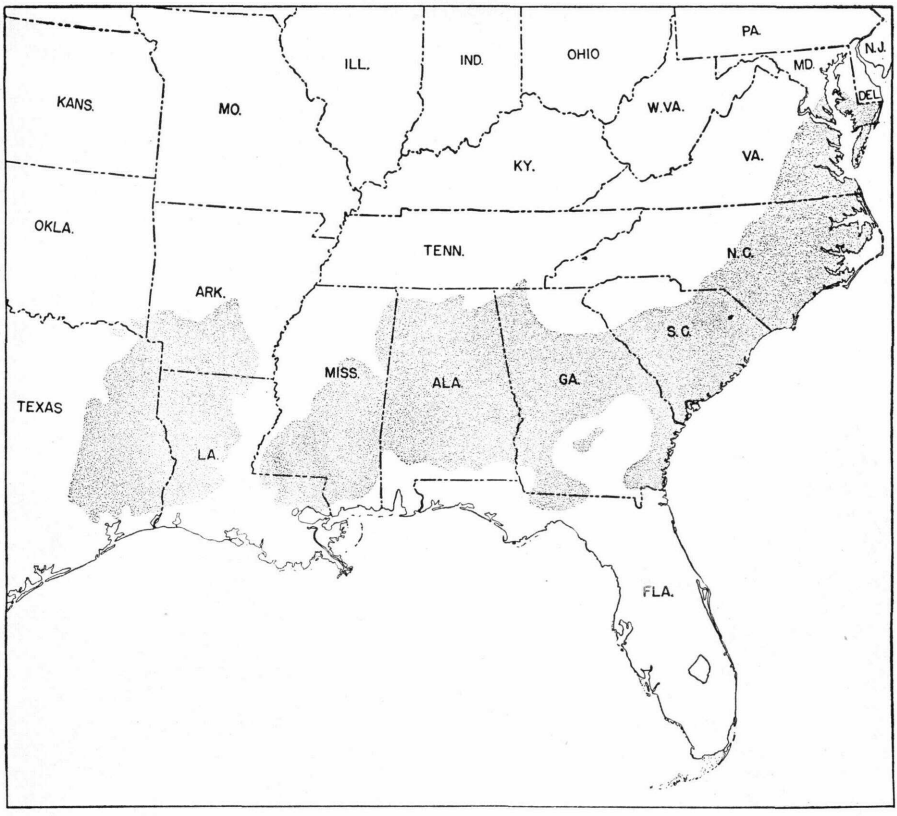

Figure 2.—Commercial range of loblolly pine in the southern United States.

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Figure 3.—Small portable sawmills account for much of the lumber produced in the area.

best trees from the standpoint of straightness, taper, and height. Improved techniques for wood preservation and an expanding demand in recent years have resulted in local markets for pine fence posts. These can be harvested in part from trees too small for pulpwood, permitting a larger revenue from early thinnings. Although some loblolly fuelwood is sold, most of it is handled on a noncommercial basis for domestic use on farms.

NATURAL SEEDING AND PLANTING OF LOBLOLLY PINE

Forests of virgin loblolly pine are not common. Much of today's "old growth" timber is actually second growth of advanced age which has escaped killing fires and cutting. The present tremendous area of second growth is mainly due to loblolly pine's ability to produce abundant seed and

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Figure 4.—This fast-growing young loblolly pine is on an old field abandoned for farming about 10 years previously.

grow in a wide variety of soil and cover conditions. This is why we have so much old-field loblolly in the South Atlantic States, particularly in the Piedmont, and is also why the less aggressive longleaf pine has been replaced by loblolly over much of its former range in the Coastal Plain (fig. 4). The total area of pure or nearly pure stands of loblolly pine in these States amounts to about 13 million acres, with additional millions of acres in lighter, mixed stands.

In recent years the trend toward more loblolly pine has reversed. One reason is that agriculture has become more stable and less land is reverting to forest. The loggers' preference for pine is another factor; each cutting leaves more hardwoods or brush behind to occupy the land. In addition the natural trend is toward hardwood (fig. 5). Thus, thousands of acres bought or held primarily for pine production are reverting to less valuable species. In many cases, this is a gradual change and is most obvious and critical after the pine is harvested, particularly if adequate measures are not taken to reestablish the pine. Maintaining a

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Figure 5.—**Typical of many in the Coastal flatwoods, this 45-year-old loblolly pine stand has a dense understory of gums, oaks, and other species. Occasional large hardwoods are in the overstory.**

productive loblolly pine forest can be accomplished by most owners or managers if they make use of the available knowledge.

Cone and Seed Characteristics

Male and female flowers of loblolly, as for all pine, are borne separately on the same tree. Flowering occurs during March or April depending upon location and the weather. The yellow male flowers are found in large clusters around the bases of young shoots, from which the wind blows pollen to the tiny female flower. The latter are small conelets, in clusters of three or two or solitary, located at the tips of new shoots. After pollination, the female flowers develop slowly; at the end of the first summer the conelets are only about ½ inch long. Ripening occurs in the second year, usually in September or October (fig. 6). At the base of each scale of a ripe cone are two seeds. Near the tip and at the base of the cone the seeds are often undeveloped. Usually about 60 percent of all seed is fertile. Fertility tends to be highest in good seed years and lowest in poor years. If done within 10 minutes after picking, cones may be tested for ripeness by floating in motor oil (SAE 20). When three or more out of five float, they are ripe. From 400 to 1,100 closed cones are required to make one bushel. This will yield 8 to 24 ounces of cleaned seed, numbering 16,000 to 20,000 per pound.

Most States have active cone-purchasing programs to supply their forest nurseries with seed. Purchasing is through local forestry officials from whom prospective cone collectors can obtain information on quantities needed and prices paid.

Obtaining Natural Seeding

An obvious way to establish a new stand of loblolly pine is to plant nursery-grown seedlings. This may be the only solution on abandoned old fields or in certain heavily burned or cutover areas, away from seed-bearing trees. But in most forest areas containing loblolly pine, natural reseeding should do the job. Important in this connection is an ample supply of seed. The amount needed varies a great deal, depending on the condition of the ground surface on which it falls. In favorable Coastal Plain locations with small losses of seed to rodents and birds, a fall of at least 25,000 sound seeds per acre is needed for adequate reforestation. This requirement will rise to 50,000 sound seeds or more on areas of heavy brush or logging debris.

In planning for natural reseeding, keep in mind that heavy seed crops generally occur at 3- to 5-year intervals. Light crops, which may be sufficient if fully utilized, are borne in most intervening years. By comparing numbers of immature cones with old cones, crops can be estimated quite accurately 6 months to a year in advance. With this or other techniques most State forestry organizations keep informed as to crop prospects. This information is usually available on request.

Good seed trees are very important to a program of natural reseeding (fig. 7). Some loblolly pine trees produce small amounts of good seed at 12 to 15 years of age. But the best yields are from trees 35 to 60 or more years old. In good years, stands of sawtimber trees usually furnish plenty of seed. In poor years the supply may be considerably less than needed. Consequently, good seed trees should be favored as much as possible.

The best indicator of a good seed tree is the presence of old cones—the more the better. Stem diameter gives another clue. Therefore, trees 14 inches and larger in diameter with old cones are the best seed producers. Furthermore, trees, like farm animals, should come from the best parents. Consequently, the seed trees selected should be of the highest possible vigor

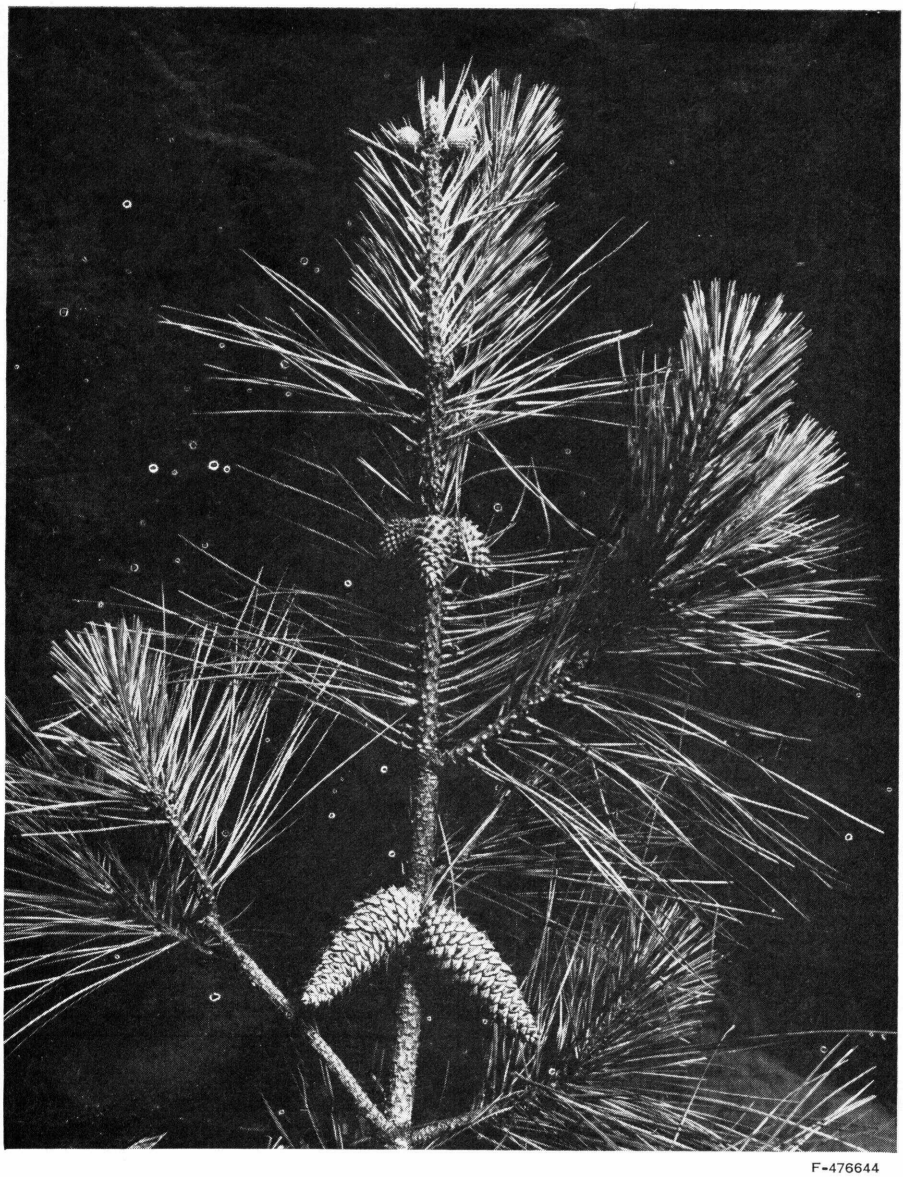

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Figure 6.—**Pine top as it appears in May, showing cones in three stages of development: mature cones that ripened last year; immature cones that will ripen this year, and immature conelets that will ripen next year.**

and quality. In any case, be sure to leave enough seed trees. Obviously, 8, 10, 12, or more seed trees per acre give greater assurance of sufficient seed than do smaller numbers. The larger timber volume involved is also a better inducement for their later removal in a commercial sale. By no means write them off as a financial loss. They frequently are sold at no loss in stumpage

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Figure 7.—Good seed trees are important to a rapid and adequate reseeding on cutover areas.

value and because of accelerated growth usually have a greater merchantable volume.

Removal of seed trees will result in some damage to young growth. If seed trees are carefully removed when seedlings are 1 or 2 years old, the damage is small. In areas of high fire risk seed trees can be retained as insurance. Their removal may then be delayed until the reproduction is ready for its first thinning, in 15 or 20 years.

The handicap of poor seed years can be offset by increasing the output of individual seed trees; releasing selected trees raises seed production from 2 to 20 times. Surrounding stems are removed to free the seed tree tops by about 10 feet on all sides (fig. 8). This can be done during a normal series of improvement or partial cuttings. If done just in advance of a final harvest as a preparatory cut, keep in mind that there is a lapse of about 3 years between release and greater amounts of seed. However, when increased production is attained, it stays up for at least several years.

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Figure 8.—**Seed production is stimulated by releasing seed trees before harvest cut. *A*, Tree released 3 years before removal of stand. *B*, Cleared area around base where cut averaged 550 board-feet per released tree.**

Next in importance to an adequate supply is a favorable surface (seedbed) on which the seed can germinate. A seedbed of bare soil is more than four times as effective as ground covered with pine straw or slash. But good catches of seedlings are obtained with about half the seedbed area scarified to bare soil. In many cases the surface is adequately scarified as a result of logging, particularly where the cut is heavy and the products are dragged or skidded over the ground.

If supplemental seedbed preparation is needed, it can be done in a number of different ways. Where the brush is light, a stump or two dragged by a small tractor will do a good job. In heavier brush tractor-drawn disk harrows are often used—size of equipment needed is governed by amount and size of brush on the area to be treated (fig. 9). Because stumps and logging debris interfere with scarification after logging, it is best to scarify before cutting. In some locations a good seedbed can be prepared by burning (see page 30).

Regardless of method of seedbed improvement, it should be done before rather than after seedfall lest the treatment destroy or bury the seed. Loblolly cones open on the tree beginning about mid-October. Most of the seed falls shortly after the cones first open, and by the end of December about 85 percent has usually fallen.

The general principles regarding the seed tree method, seed supplies, and seedbed conditions which will aid in obtaining better natural reseeding of loblolly pine in even-aged stands can be summarized as follows:

1. For maximum seed production release seed trees 3 to 5 years before main harvest of trees.
2. Leave plenty of seed trees (from 8 to 12 per acre) and plan to harvest them as soon as new crop of trees is well established.
3. Cut sparse or badly depleted timber or very brushy areas in good seed year only. Do this after the seed is down.
4. Where seed supply is likely to be inadequate, prepare a seedbed to facilitate natural reseeding, or plant nursery-grown seedlings.

Some Pointers on Planting

Where natural seeding is unlikely or impossible, planting is in order. Within its natural range loblolly pine can be planted successfully in most locations. In the Coastal Plain only wet or very poorly drained locations and deep, dry sands should be avoided. In the Piedmont varying topography, past land management, and other factors make the selection of planting sites more difficult. Because of this, the following guides have been established for planting loblolly pine in the Piedmont:

1. Avoid spots that obviously have poor drainage.
2. Avoid eroded areas where only subsoil remains, unless the object is mainly to stop erosion. A top layer of sandy, surface soil (topsoil) is desirable for good growth but not essential for success. Loblolly is superior to other southern pines in its ability to stop erosion quickly.
3. No special soil conditions are needed, but better growth is obtained on the lighter textured and deeper soils.
4. A light to moderate cover of broomsedge or weeds is beneficial to early establishment.
5. Loblolly should be confined mostly to its natural range; generally the lower half of the Piedmont.

Year-old loblolly pine seedlings suitable for local planting can usually be obtained at a small cost by applying to the State Forester located in your capital city, except for Virginia, where the headquarters are in Charlottesville. Seedlings can also be ordered

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Figure 9.—A good seedbed results in a more rapid and complete restocking with loblolly pine following a harvest cutting. Views are adjacent on same area, 4 years after cutting. *A*, Portion with no advance seedbed preparation; *B*, portion scarified with heavy disk harrow before seedfall and logging.

through county agents or farm foresters. This should be done well in advance of planting time, which is usually in December, January, and February. From county agents and State Foresters you can obtain printed, illustrated booklets on the proper ways to plant trees. Successful planting depends on following these instructions.

Generally no ground preparation in advance is needed to plant loblolly pine on abandoned fields and pastures, or recently cutover areas. Sometimes burning either immediately before or a year before makes hand planting easier, and burning immediately before may simplify machine planting in brushy areas or where there are many briars or weeds. In heavy sod it may help to remove a 15- to 20-inch square with a grub hoe before planting. Another method involves plowing single furrows 2 or 3 inches deep; this is done several months in advance to allow for soil settling. In hilly areas these should follow the contour.

Hand planting can be done with almost any tool that will open a hole large enough for the tree roots and will pack the soil firmly afterward (fig. 10). The most common tool is a planting bar or dibble which can be purchased or homemade. Hand planting is best for small areas, brushland, or sites with many stumps or logging debris. It is a 1- or 2-man job and under average conditions about 100 trees per man-hour can be planted.

Large areas free from brush, such as old fields, can best be machine planted. The machines are available in most localities at various rates of hire. Quality of planting is good and two men can plant up to about 9,000 trees per day.

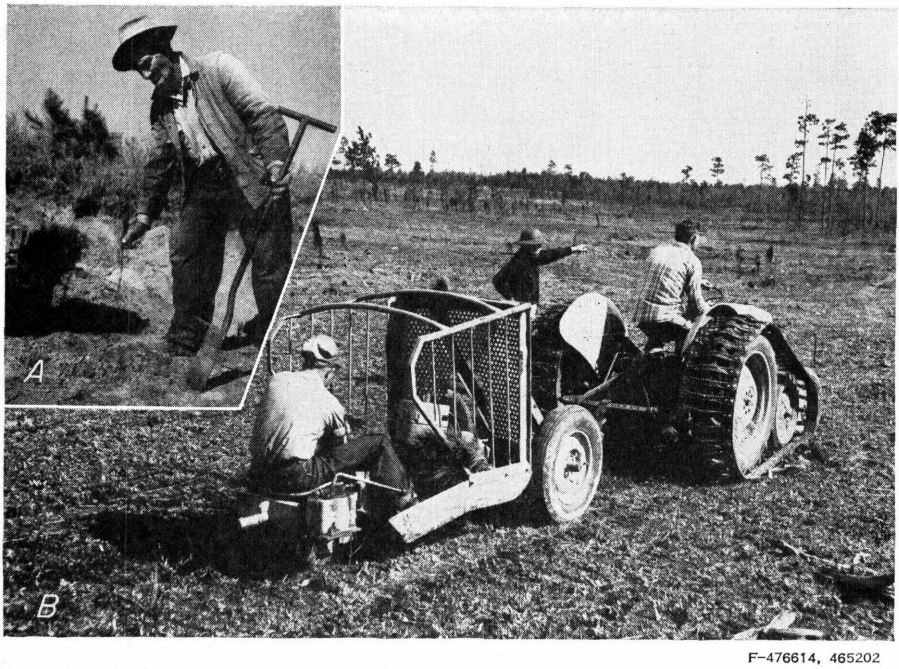

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***Figure* 10.—*A*, This farmer plants several thousand loblolly seedlings each year on his eroded hillsides. *B*, Planting machines, which are available in many localities, can be drawn by most farm tractors.**

General spacing recommendations for planting loblolly on farms and small ownerships are as follows:

1. Where good and accessible markets for posts are assured, space trees 6 by 6 feet (1,210 per acre).
2. Where the foregoing market is uncertain, space trees 6 by 7 feet (1,037 per acre) or 6 by 8 feet (908 per acre).
3. In small erosion-control plantings, where quick, complete coverage of the ground is essential and initial mortality is likely to be high, space trees 4 by 4 feet (2,722 per acre).

Direct Seeding Is Difficult

Sowing seed by hand or machine directly on the planting site is a tempting alternative to planting seedlings. As a rule, however, direct seeding involving application of small amounts of seed has not succeeded very well. Considerable seed is lost to rodents and birds. Even if the seed is not destroyed, insects and disease often take a heavy toll of newly germinated seedlings. Drought is an even greater hazard, since a few dry days in the early growing season or a prolonged dry spell later may kill all or most of the trees. At the present time, with 1-year-old nursery-grown seedlings easily available for planting, direct seeding is not recommended as a general practice.

TREATMENT AFTER NATURAL SEEDING OR PLANTING

Control of Weed Trees

Inferior hardwoods and brush may interfere with the establishment of a young stand of loblolly pine. The larger hardwoods not only compete for soil and moisture but also act as a mechanical barrier. Actually, they reduce the space available for pine by approximately the area under their crowns. Liberation of pine seedlings from large or small competing stems is usually done by cutting, girdling, or poisoning. Usually by about the third year after logging the need for treatment is evident.

In carrying out a program of pine release, use the following general guides:

1. *Girdle hardwoods above 12 inches in diameter, as sprouting is seldom serious from larger trees.* Cut completely around the tree, through the bark and well into solid wood. Cut above forks and fire scars. Cut c o m p l e t e l y through any wound callus.
2. *Poison hardwoods under 12 inches in diameter if the overtopped pines are less than 2 feet high.* Use proper amounts and concentrations of chemicals. Better too much than too little.
3. *Girdle or cut down hardwoods if suppressed pines are more than 2 feet high.* Pines of this size will usually outgrow new sprouts that result from cutting or girdling.
4. *Treat only hardwoods which cannot be sold.* Oftentimes pine release can be done at a small cost or even at a profit by harvesting and selling the overtopping trees.

For tree poisoning, some chemicals are more effective than others, although this may vary by species and localities. In the Southeast good hardwood control is obtained with Ammate and with numerous brands of 2,4,5-T (4 pounds of acid per gallon, low volatile esters). Both are nonpoisonous to man or animals. Ammate is very corrosive to metal and may cause skin irritation. 2,4,5-T kills trees more slowly. Common methods of application are as follows:

1. *Notches or cups.* This is a good method for trees 1 inch in diameter and larger. Cut notches around base of tree equal in number to one-half of tree diameter in inches. Notch deep enough to hold 1 heaping tablespoon of Ammate crystals (fig. 11). On trees small enough to cut with

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Figure 11.—**Most weed trees can be quickly killed by using Ammate crystals in notches or "cups."**

two blows of an ax apply Ammate to the notched stump top. This is generally the most effective all-around chemical treatment.

2. *Frills.* This is a useful treatment for trees 5 inches in diameter and larger. It is generally the cheapest method. At a convenient height circle trees with overlapping ax cuts. Chop at an angle through bark and into wood, taking care not to break wood or bark away from tree. Pour chemical solution into resulting frill to point of overflow (fig. 12). A solution of Ammate usually consists of 2 pounds of crystals to 1 gallon of water; 2,4,5-T is usually mixed at the rate of 1 gallon of commercial concentrate to 50 gallons of water, or fuel oil.

Poisoning in frills is not recommended for trees under 5 inches in diameter, as many break off at the frill before the chemical acts.

3. *Basal Spray.* This method is best used on trees under 2 inches in diameter. It usually involves an oil solution of 2,4,5-T (1 gallon to 20 gallons of fuel oil or kerosene). To apply, spray tops and sides of stumps to point of runoff. In treating standing trees, spray to point of runoff a band of bark 12 inches wide at base of trunk, encircling tree. Chemical cost generally restricts this treatment to small stems.

Cost of hardwood control largely depends on method used and number of trees treated. Girdling requires no chemical and is thus wholly a labor

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Figure 12.—A, Since 2,4,5-T is noncorrosive, it can be poured into frills from ordinary metal containers. A 1-gallon kerosene can will do. Back-pack cans, holding about a half-day's supply, are easily adapted for gravity flow. B, Red oaks show a characteristic bark bursting when treated with 2,4,5-T.

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cost. About 1 man-hour is required to girdle 40 trees 5 inches in diameter or 20 trees 10 inches in diameter. Chemical-in-frill treatment involves less labor than girdling and costs no more, even though the expense of chemical must be added. Poisoning with Ammate crystals in notches is somewhat more expensive. Treating 40 trees 5 inches in diameter requires about 1.6 man-hours of labor in addition to 8 pounds of chemical. Basal sprays can be used economically to poison trees too small to frill or notch. Excellent control of trees averaging about 1 inch in diameter is possible at a cost of less than one-half cent per tree for chemicals and labor.

Enemies of Young Trees

Fire

Protection from wildfires is essential to the successful establishment of naturally seeded or planted loblolly pine. This is particularly important during the first 6 to 10 years. During this period the bark is usually too thin and the trees not tall enough to escape damage. Most, if not all, of these seedlings and saplings are likely to be destroyed by ordinary fires. In many localities, it pays to supplement available public fire protection with firelines plowed around areas of young pine.

Livestock

Sheep and goats should be kept out of newly established loblolly pine, at least until the buds and most of the foliage are out of their reach. Afterwards, they may serve the useful purpose of helping to keep out undesirable hardwoods and brush.

During the early years cattle can kill seedlings by browsing, or saplings by trampling. But damage is generally light except near concentration points. Elsewhere, cattle grazing may help reduce fire hazard and in certain areas offer an attractive source of income until crown closure greatly reduces the forage.

Insects

Tip moths may damage young loblolly pine by reducing height growth and causing some trees to crook or fork. Damage can be quite severe on poor sites. The commonest evidence of tip moth injury is dying or dead twig tips. Artificial control is possible on a small scale by means of a thorough spray of 1 percent DDT applied during the first flight of moths (late March or early April); a second application may be needed during the second flight, later in the growing season. Control is seldom needed on good sites, as evidence of damage often disappears before trees reach pulpwood size.

Serious losses of young seedlings may result from pales weevils. They feed on the tender bark, girdling the stem and even the roots to depths of from 1 to 5 inches. The insects breed in pine stumps and are attracted to freshly cutover areas. Practical control measures for natural reproduction have not been determined; but the danger from pales weevil seldom lasts more than 1 year after cutting.

Pine webworms have sometimes caused large losses, particularly in the Piedmont section, by completely defoliating young seedlings. The larvae or worms are found in masses of webbing and frass, numbering from about 3 to 25 per nest. They can be controlled with DDT (1 percent in water) or arsenate of lead (2 pounds in 50 gallons of water).

Disease

Loblolly pine is comparatively free from diseases. The most serious is southern fusiform rust in young trees. This fungous disease causes sweetpotato-shaped cankers on the branches or

stems of seedlings and saplings (fig. 13). On larger trees it is responsible for elongated scars on the trunk at any height. Stem infections on seedlings and saplings are likely to girdle and kill the trees quickly. The cankers may reduce lumber yield and quality of sawtimber, and large trees sometimes break off at the canker in heavy winds. Control of the disease is difficult. If cankers are less than 15 inches from main stem, pruning will reduce damage from branch infection. The number of infected trees can be reduced through a normal course of thinning and improvement cuttings.

Needle blight is a spectacular if not serious disease of loblolly pine. The needles of both large and small trees are attacked but it is more evident and alarming on the younger trees. At the peak of infection the dieback of needles becomes so heavy that many trees appear to be dying. When severe, the disease may affect the growth of young trees, and small seedlings may be killed.

Spot die-out is a relatively new disease of young loblolly pine. The cause has not been determined. In some Piedmont areas 10- to 15-year-old loblolly pine plantations have been severely damaged—patches of dead trees range from about one-tenth to 25 acres in extent. Mortality appears greatest on very poorly drained soils with little or no topsoil.

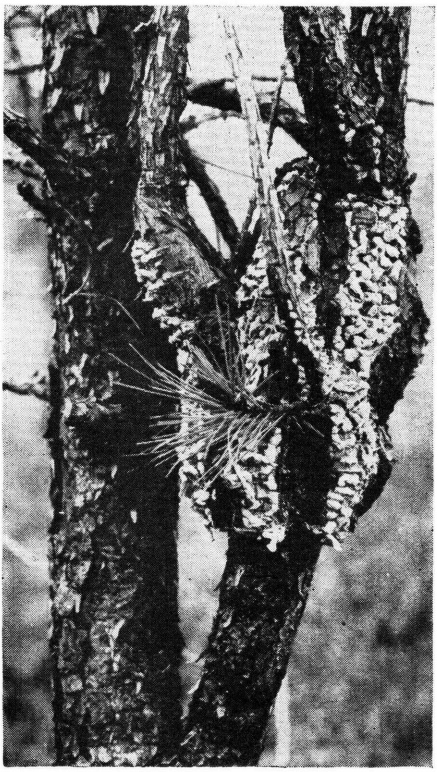

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Figure 13.—Fusiform rust cankers in fruiting stage on a young loblolly pine.

WHAT TO DO IN YOUNG OR PULPWOOD STANDS

Pruning for Quality

Close-growing loblolly pine will develop clear stems naturally. Open-grown pines tend to develop large, persistent limbs which seriously affect the future yield of quality timber. This can be avoided by hand pruning promising trees in young stands. Early pruning is cheapest and gives best results—smaller knots and more clear lumber. Don't prune unless you plan to allow the trees at least 25 years for growing into sawtimber.

Trees to be pruned should be chosen from among not more than 100 to 125 (20- by 20-foot spacing) of the best formed, disease-free trees per acre. Trees should preferably be about 3 to 5 inches in diameter. Pruning to a height of 17 feet to clear one 16-foot butt log is most profitable. If tree height is under 25 feet, this requires two operations, but only one is needed if trees are taller. This is because a live top equal to one-third the total tree height should be retained to maintain growth rate.

Do not prune with an ax. Saws are the best tools for pruning. Frequently the lower 8 feet or the first pruning operation is done with a hand saw—

one with coarse incurved teeth is best. Unless a ladder is used, the upper section requires a pole saw (fig. 14). This is usually a narrow, curved blade, about 18 inches long, having 5 to 7 teeth per inch and mounted on a wooden or aluminum handle 10 to 12 feet long. Clean, close cuts should be made, leaving no branch stubs. Pruning can be done any time of the year.

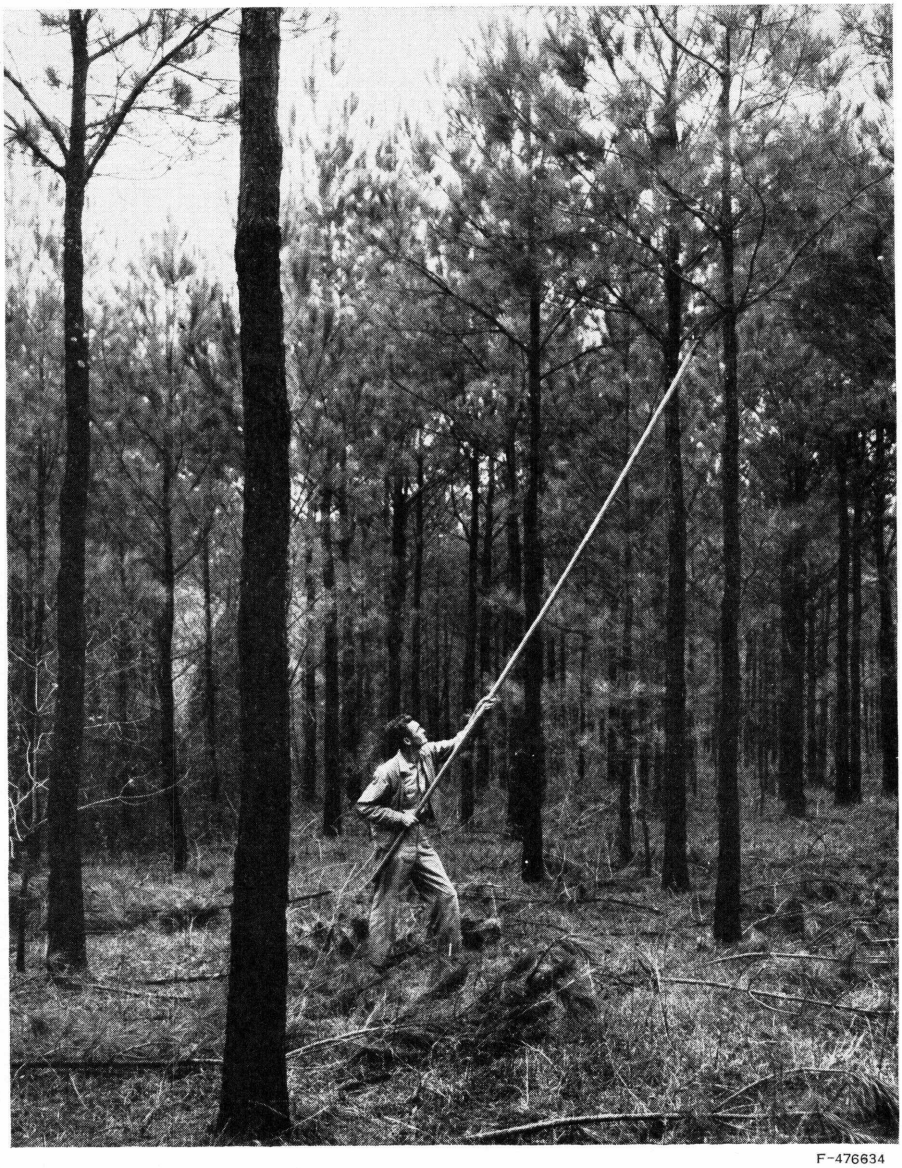

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Figure 14.—A pruning operation in progress in a young, open-grown stand of loblolly pine. The pole saw permits pruning upper section of a butt log while worker stands on ground.

Pulling severed branches away from base of trees will reduce possible fire losses and, in case of midsummer droughts, will help to avoid insect damage.

Pruning costs vary with many factors such as number and size of trees, height of treatment, tools used, and class of labor. Generally it takes about 5 to 9 minutes, including walking time, to prune a tree to the height of one log. Thus, the total cost is usually quite reasonable and, in view of the value differential between rough and clear lumber, is well worth the effort. It is a cultural treatment that is particularly well suited to the working habits and tools of the farmer and small landowner. Farmers and their tenants are in good position to do some pruning at odd times when other farm work is light.

When Is Thinning Needed

Early cash returns can be realized by thinning crowded young stands of loblolly pine. In the process, future growth is concentrated on the best trees. Furthermore, many trees sure to die can be salvaged at a profit.

If the aim is to grow sawlogs, thin dense stands as soon as a commercial pulpwood or fence post operation can be made from the trees to be removed. Short crowns are good indicators of the need for giving trees more room to grow. Trees up to 30 feet tall should have at least 40 percent as crown (branches with foliage). The minimum for taller trees should be about 30 percent. Thus a 20-foot tree requires 8 feet and a 50-foot tree needs 15 feet of crown for good growth. In dense stands, thinning can and should start at about 15 to 20 years of age (fig. 15). The interval between thinnings should be about every 5 years, with longer intervals as the stand ages. Each cutting should be heavy enough to maintain the indicated crown lengths among the crop trees (those to be kept for later harvest).

A recommended rule of thumb for spacing crop trees in loblolly is to leave a space in feet between trees equal to 1¾ times the average tree diameter in inches. For example, where average tree diameter equals 8 inches, spacing should be 14 feet (8 x 1.75) between trees left to grow. However, trees too small to be merchantable should be left standing, as they have very little effect on the growth of larger trees. Crop trees should be designated as soon as possible. At the initial thinning, they may be selected from straight, clean, fast-growing trees. Trees to be cut are those in excess of the crop trees, mainly the small or slow-growing ones, and those which are crooked, diseased, or injured. The first thinning is also the best time to remove excessively limby trees to favor better ones. Retain poorer trees if their removal will result in excessively wide spacing.

Thinning is not always necessary. Obviously many open-grown stands need not be treated. Others contain dense patches which alone should be thinned. Understocked stands most often need improvement by the cutting of large limby trees or poor trees which are interfering with small ones of better quality (fig. 16).

Harvesting Young Timber

Loblolly pine can be grown profitably on a 40- to 50-year rotation (age from seed to final harvest), such as most pulp and paper companies aim at, if the primary objective is pulpwood and small sawlog production. For various reasons some owners may want to cut all of their timber at an earlier age. In any event, the financial aspects are quite important, as is the problem of establishing a new stand of loblolly pine.

An owner can make money on short rotations, but he loses if he harvests too early. For instance, studies in Vir-

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Figure **15.—A dense 18-year-old stand of loblolly pine ready for its first commercial thinning. Pulpwood, pine posts, and fuelwood will be the principal products.**

ginia and North Carolina show that harvest at 25 to 30 years yielded 25 cords of pulpwood, or a gross return of $100, per acre. In contrast, by thinning for pulpwood at 25 to 30 years and then carrying the remaining stand 10 years longer to small sawtimber size, an owner can gross nearly three times as much. Thus it appears possible to earn in a single 40-year rotation a gross return greater than that produced by two short rotations in a period of 50 to 60 years at prevailing stumpage rates.

Moreover, stands under 35 years of age are more difficult to replace by

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Figure 16.—**An understocked stand of 20-year-old loblolly pine after first improvement cut. Crop trees marked with paint spots have been pruned to a height of 17 feet.**

natural seeding. Seed production from young seed trees is usually inadequate. Some owners try to overcome this difficulty by planting. But in this case pales weevil damage is a real danger. It is safer to have older seed trees, producing abundant and recurring crops of seed which will restock the area if not in one year then in another.

Those seeking natural reseeding from young stands should read pages 6 to 10 before making final cutting plans. Particularly important is the release of seed trees several or more years before final harvest. It is also highly desirable to cut between January 1 and March 1 after the main seedfall.

HANDLING SAWTIMBER STANDS

Improvement and Harvest Cuttings

Cuttings to thin the stand and take out damaged or injured trees should continue until the final harvest. In thick stands, these will mainly be thinnings. In thin stands cut more lightly so as to improve the stand to be left and restrict the thinning to dense patches. In all cases concentrate first on the poorest trees, such as:

1. Those recently dead.
2. Insect-infested trees.
3. Those badly overtopped by larger ones.

4. Trees with obvious rot.
5. Heavily leaning trees.
6. Those with serious fire scars.
7. Trees with big fusiform rust cankers, particularly in first or second log.
8. Large, excessively limby trees crowding better ones.
9. Trees too crooked for sawtimber.

Obviously some better trees have to be cut too, mainly to provide more growing space by thinning. Eventually only the best trees will remain as the final harvest approaches.

The interval between cuts will vary by tract and owner. It may range from 3 to 10 years. Thick stands can and should be worked over oftener than thin ones. This is to reduce losses from mortality and to get the most out of rapid growth before the tree crowns begin to close in again. On the other hand, many thin stands cannot provide a commercial cut at frequent intervals without seriously reducing final yield. In fact, the primary goal in these stands should be gradually to increase the volume of the growing stock of standing trees. This can be done only by cutting less volume than can be grown during the intervals between cuts. To determine the allowable cut for an individual tract accurately requires a knowledge of the actual volume of the standing timber and its growth rate. A local forester can help you work this out.

Some farmers may want to do some cutting every year as a means of getting a cash income. In such cases the woods can be divided into smaller blocks to coincide with the predetermined cutting cycle. Thus a 5-year cycle would require five blocks, or one to work in each year.

Most of our present loblolly stands came in after a fire or seeded in on an old field, or grew up after a heavy cut. For this reason, trees in the average loblolly stand are all about the same age. If they escape subsequent fires or other damage, these tracts of loblolly characteristically grow up into thick stands of uniformly distributed trees. Because of these characteristics, the simplest management is to aim for a succession of similar, dense, even-aged stands (even-aged management). Consequently, after partial cuttings for thinning, improvement, and salvage have left a final crop of trees of a quality and size to suit the owners' needs, they are usually clear cut except for seed trees. This may be as early as the 40th year and up to about 80 years. Action required to obtain adequate natural seeding at this time is fully discussed in pages 6 to 10.

Very often when second-growth loblolly pine is placed under management for the first time, a system as described above may be quite difficult. This is particularly true where the land bears a miscellaneous mixture of seedling, sapling, pole, and sawtimber trees. An attempt to convert such a stand rapidly to a more uniform condition may result in a wasteful cutting of young trees before their time.

Tracts like the foregoing are often well adapted to a selection, or many-aged, system of management. Under such a system trees are always removed singly or in small groups, and each tree is cut or left according to its individual merits. Diseased, crowded, or limby trees are removed in each cutting operation and the more mature, better trees cut as needed to complete a cutting quota or allowable cut. Timber stand improvement measures described on pages 13 to 17 are generally applicable. Prescribed fire cannot be used because of probable damage to pine reproduction. Other seedbed preparation measures (described on page 10) are applicable but only as needed in the small openings which do not have a satisfactory number of pine seedlings. The chances of good seedling catches are improved by cutting on short cycles, 3 to 5 years, so that seed production stimulated by the previous cutting will still be high.

The practical application of any management system varies from tract to tract, and the advice of a local forester will be helpful in determining the one most suitable for a particular farm forest.

Growth and Yields

Soil, drainage, rainfall, temperature, steepness and direction of slope, and other factors directly influence the amount of wood that can be grown. A convenient measure of the land's capacity to grow loblolly pine is the average total height—from base to top—attained by the larger or dominant trees in a stand at a given age, as shown in table 1.

Application of the table is simple. One needs only to know average age and total height of the larger trees, and to classify stand density. On a small tract the average age and height from 8 or 10 well scattered trees will often suffice. Stand density may be judged ocularly, either as a thin stand (open-grown) or a full stand (close-grown). As an example, we can assume larger trees in a given tract averaging 25 years of age and 60 feet in total height, and a full stand of timber. Reference to table 1 (second line, seventh column) shows good quality land is involved. On the other hand, if average total height had been only 37 feet, table 1 shows (second line, fifth column) poor quality land.

Cutover lands, of course, have no trees. What about such areas? Even here, a forester can tell you by soil measurements whether it is productive loblolly pine land or not.

Loblolly pine has not been managed long enough to determine fully the total amount of wood that can be grown and harvested per acre in managed stands. Studies now under way will give us the answer fairly soon. In the meantime we can be guided by information obtained from thick, unmanaged stands which have never been thinned (table 2).

The values in the table apply to loblolly pine lands of average quality, where dominant trees will attain the height of 75 feet in 50 years. Obviously, better land will grow more, and poorer land less than the table shows. Furthermore, the indicated

TABLE 1.—*Average total height of dominant (larger) loblolly pine trees at various ages for different qualities of land* [1]

Age of trees (years)	Thin stands			Full stands		
	Poor land	Average land	Good land	Poor land	Average land	Good land
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
20	24	36	46	28	40	50
25	32	43	55	37	48	60
30	37	51	63	42	56	68
35	44	56	71	49	62	77
40	47	62	76	53	68	82
45	51	66	80	57	72	86
50	54	69	84	60	75	90
55	56	72	87	62	78	93
60	58	74	90	64	80	96
65	62	76	93	66	82	99

[1] Derived from figure 7 and table 9 of *Volume, Yield, and Growth of Loblolly Pine in the Middle Atlantic Coastal Region.* U. S. Forest Serv., Southeast. Forest Exp. Stat., Tech. Note 33, 30 pp. 1939.

TABLE 2.—*Average number, size, basal area, and volume per acre of dominant and codominant loblolly pines at various ages in fully stocked unmanaged stands on average site (ite index 75)*[1]

Age of trees (years)	Average height	Average diameter at breast height	Trees	Basal area	Merchantable volume [2]	
					Pulpwood	Sawlogs
	Feet	*Inches*	*Number*	*Square feet*	*Cords*	*Board-feet*
20	40	5.8	470	89	16	2,000
30	56	8.2	290	104	26	8,400
40	68	10.2	210	114	35	14,700
50	75	11.6	170	122	43	19,900
60	80	12.8	145	128	49	23,300
70	84	13.8	130	133	53	26,500
80	86	14.6	120	137	57	28,700

[1] Derived from tables 33 and 59–63 of *Volume, Yield, and Stand Tables for Second-Growth Southern Pines*. U. S. Dept. Agr. Misc. Pub. 50, 202 pp. 1929 (out of print, may be consulted in libraries).

[2] Merchantable volume in this case means either pulpwood or sawlogs—not both. Utilization assumed to a fixed top diameter of 3 inches for pulpwood (stacked cords, including bark) or 5 inches for sawlogs (International log rule with ¼-inch kerf).

rates of production can be improved by periodic thinnings to provide more growing space. In addition, total production could be increased by the timely salvage of merchantable trees that would otherwise die. Thus, better results can be expected from well-stocked stands under management.

Many stands do not have enough trees to produce maximum volume. Wildfire, insects, disease, and overcutting are basic reasons. Often too, heavy brush, insufficient seed, and poor seedbed conditions have prevented the establishment of enough seedlings to make a full stand. On all such tracts, the forest manager must be satisfied with lower yields.

For accurate appraisals each tract must be considered on its own merits. This will require the services of a trained forester. On the other hand, it is of some help to know what to expect under average conditions. Average productivity of loblolly pine land in South Carolina approximates the average for the Southeast. A survey made in South Carolina in 1947 provides some useful information on average volume and growth (table 3).

The average age by stand sizes would be about 25 years for pulpwood, 40 for small sawtimber and 65 for large sawtimber stands. By comparing values in table 3 with similar values in table 2 for the given ages, it is seen that average stands are producing substantially less volume than is possible. Again it should be pointed out that the stated values primarily reflect yields of unmanaged stands which can be improved by management. Even so, annual growth in these average stands is at the rate of over 9 percent for pulpwood, 6 percent for small sawtimber, and 4 percent for larger sawtimber stands. Because of high growth rates, many owners may choose to postpone harvest cutting until the stand has increased its volume and total returns are greater.

Cost and Returns

Inasmuch as the chief purpose of managing loblolly pine is to make money, the average owner wants to know his chances for profit. Net return, like timber yield, varies widely from tract to tract. Nevertheless, from

TABLE 3.—*Average volume and annual net growth of sound trees per acre for loblolly pine by stand size in South Carolina, 1947* [1]

Stand size	Average volume		Net growth	
	Sawtimber [2]	Pulpwood [3]	Sawtimber [2]	Pulpwood [3]
	Board-feet	*Cords*	*Board-feet*	*Cords*
Large sawtimber [4]	9, 355	26. 0	380	1. 1
Small sawtimber	4, 185	15. 2	295	. 9
Pulpwood	855	8. 4	75	. 8

[1] Includes hardwoods and pine. Derived from tables 12, 13, 17, and 18 of *South Carolina's Forest Resources*, 1947. Southeastern Forest Experiment Station. Forest Survey Release 28, 122 pp. 1949.

[2] International log rule with ¼-inch kerf.

[3] Pulpwood volume also includes sawtimber trees.

[4] Stands having more than 50 percent of the volume in pine trees 15 inches or larger in diameter breast high.

the foregoing and other information at hand, many owners can estimate their costs and returns within reasonable limits.

Actual cash cost to many owners may be quite small. Oftentimes, through the State forester or local conservation groups, small quantities of planting stock can be obtained free. At the most, only nominal charges are made. Fire protection, although inadequate in some localities, is generally a free public service. Most States also provide the services of trained foresters to help landowners with management problems. Generally this includes on-the-ground examination and advice, followed by written recommendations for timber cutting, fire protection, and planting. If timber is to be cut, additional service may also be available. Often this includes marking the trees to be cut, a volume estimate by products, a buyer list, suggestions for advertising, and a sample timber sale contract. Some States provide this service free; others make a small charge based on the volume of timber marked.

Most owners are adequately informed on fixed costs, such as taxes. Land values, if unknown, can be estimated from recent local sales of forest land. For timber valuation, local stumpage (standing timber) rates can be applied. Most troublesome are cost estimates for various forestry measures. In this connection the results of a South-wide survey made in 1952 may be helpful (table 4).

Many of the charges in table 4 are for labor. Obviously farmers by doing the work themselves can keep cash costs at a minimum. In addition to doing some of the forestry work himself, it often pays the farmer to do his own harvesting if he has the aptitude and equipment. Numerous studies have shown that a farmer can earn $1 per hour or more (in addition to what he gets for stumpage) by cutting sawlogs, pulpwood, and other products and assembling them at the roadside or other readily accessible place (fig. 17).

To demonstrate what a farmer can do in his woods with farm tools to get an annual cash income while improving the quality and quantity of remaining timber, a 33-acre farm woodland has been under management for 5 years at the Santee Experimental Forest in South Carolina. Like many farm woods in South Carolina, this was at the start a rather poor stand of

TABLE 4.—*Costs per acre for various forestry opeations in the South, 1952* [1]

Operations	Groups reporting	Average costs per acre	
		Labor	Other [2]
	Number	*Man-hours*	*Dollars*
Prescribed burning	13	0. 3	0. 19
Scarifying, heavy	6	2. 2	3. 34
Planting open land:			
Hand	26	11. 0	2. 37
Machine	24	2. 4	2. 98
Planting cutover land:			
Hand	20	12. 0	2. 43
Machine	12	2. 8	3. 56
Release cutting	9	4. 5	. 55
Poisoning:			
Large trees	17	2. 9	. 38
Small trees	19	4. 3	. 53
Girdling:			
Large trees	17	4. 0	. 15
Small trees	14	4. 9	. 20
Cruising (10 percent)	23	. 1	. 10
Marking:			
Thinning	25	. 9	. 50
Improvement cuts	27	. 6	. 20
Seed tree cuts	17	. 4	. 18
Selection cuts	21	. 8	. 18

[1] Derived from table 1 of *Costs of Practicing Forestry in the South.* Ga. Univ., School of Forestry Leaflet 13, 5 pp. 1953.

[2] Too s, supplies, equipment, etc.

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***Figure 17.*—Farmers can increase their income by doing their own harvesting, if they are properly equipped and have the aptitude for logging. This is the annual cut of sawlogs, pulpwood, fuelwood, and posts from a 33-acre loblolly pine woodland in South Carolina which netted $1.06 per hour of work in excess of stumpage value.**

1- to 40-year-old loblolly pine. Improvement cuts were made annually and the products sold. A summary of the first 5-year period is as follows:

5-year production:	
Sawlogs—board-feet (Doyle Rule)	19,595
Pulpwood—standard cords (4 by 4 by 8 feet)	44
Posts ---------- pieces	543
5-year costs and returns from cutting:	
Roadside value of all products	$1,531.94
Stumpage value ($4.82 per acre per year)	$796.00
Cash costs	$184.25
Net return for labor ($1.02 per hour)	$551.69
Stand improvement measures:	
Planted ---------- acres	1.57
Pine release ---------- acres	25.30
Total labor ------ man-hours	102
Cash costs	$55.06

In addition to the foregoing returns, it is estimated that the stand per acre increased from 3,300 to 3,550 board-feet; this increase was attained by keeping annual harvests somewhat below the net growth. Under good forestry such as planting, seedbed preparation, pine release, thinning, improvement cuts, and other practices as needed, the productive capacity of this forest tract is steadily improving.

Woodland owners who prefer to market standing timber (stumpage) can obtain a fair price by following these instructions:

(1) Mark all timber to be cut. Paint two spots on each tree, one below stump height for checking after cutting and one at eye level for the cutters to see.

(2) Obtain an estimate of the amount and value of the timber to be sold.

(3) Obtain bids from several prospective buyers. Make sure that the highest bidder is a responsible purchaser. Sell under sales contract or written agreement.

(4) Ask your State or local forester for advice and assistance when you make a sale.

Enemies of Larger Trees

Bark Beetles

Beetles can cause serious damage to loblolly pine stands. Attacks may follow drought, fire, cutting, windthrow, or other damage to timber.

Perhaps the most destructive is the Southern pine beetle, whose killing power ranges from small groups of trees to hundreds of acres. The adult beetle is brown or black, about 1/8 inch long. It usually attacks the midstem portion first, followed by the lower trunk, making **S**-shaped galleries between bark and wood. Usually small pitch tubes appear along the trunk and a sawdustlike frass is seen in bark crevices and at the tree base.

The destructive engraver, or Ips, beetle can be distinguished from the Southern pine beetle by a depression at the back end of the body. In addition, Ips beetles make straight, or star-shaped galleries between the bark and wood. The beetles commonly attack dying trees from which they spread to healthy trees such as those surrounding one struck by lightning. They often kill trees weakened by drought.

The black turpentine beetle has become a serious pest in recent years. Complete stands are not wiped out, but the damage may range from a single tree to as many as 50 percent of those in a stand over a period of several years. The turpentine beetle is larger than the other beetles, being about 1/4 inch long. It breeds in stumps and attacks the base and upper roots of live trees. Activity in a tree is marked by large masses of pitch (pitch tubes) within the butt-log section.

Beetle infestations should be treated promptly. Trees infested with Southern pine or Ips beetles should be harvested and utilized as quickly as possible. The slabs or bark should be burned at the sawmill or woodyard to prevent the beetle broods from emerging. If immediate harvesting is not practicable, infested trees should be

felled and barked, and the bark and tops piled and burned. Spraying the trunks and stumps of infested trees that have been felled but not barked also helps to prevent new attacks and to contol existing beetle populations. A good spray is 0.25 percent gamma benzene hexachloride (BHC) in No. 2 fuel oil applied until the bark is wet and dripping. All control measures should be applied while the needles are still green or have not changed beyond a pale greenish yellow. By the time the needles have turned dark brown, the beetles have usually left the tree.

The black turpentine beetle kills slowly. If the tree crowns are green and the pitch masses are few in number, affected trees may survive the beetle attack. Such trees may be left in the stand and periodically observed, or they may be protected by a spray treatment. A BHC spray, 0.5 percent gamma in No. 2 fuel oil, will protect a tree for 7 months and in all probability carry it through the danger period. Heavy accumulations of white dust at the base of an infested tree indicate ambrosia beetle activity which usually forecasts the death of a tree.

Heart Rot

After loblolly pine reaches middle or advanced age, red heart is not an uncommon enemy. This fungous disease gradually rots away the heartwood, weakening the tree and destroying the value of the affected wood. Presence of the disease is sometimes indicated by unusually smooth bark, particularly in the upper stem. Fruiting bodies (or conks) on the trunks are direct evidence of the rot. So far as practicable, infected living trees should be harvested promptly to prevent further deterioration.

Littleleaf

Littleleaf disease affects loblolly pine and, to a greater extent, shortleaf pine. The disease occurs mainly in the Piedmont. An early symptom is foliage yellowing which becomes more pronounced as the disease progresses. Needle length and shoot growth decrease, and in the final stages diseased trees are obvious because of short, thin, and pale foliage confined to the ends of branches. In most areas symptoms first appear in trees older than 30 years. Affected trees are not known to recover naturally. Mortality is usually slow enough to enable profitable salvage of most trees.

Seek the help of your local forester to identify insects or disease and to plan a control program.

PRESCRIBED BURNING IN LOBLOLLY PINE

Prescribed fire is a forestry measure—like planting, pruning, and thinning—to be used at the proper place and time. When properly applied, fire is an efficient and low-cost treatment, but in unskilled hands it may be a dangerous and costly tool. The use of fire in the management of loblolly pine has been studied by foresters for many years. During this time much has been learned about its proper use and also its limitations. There are still some gaps in the knowledge. Techniques have been developed for the Coastal Plain section only. Even there its use is restricted by weather, types of fuel, management methods and objectives, ownership patterns, and public laws and policies. Prescribed burning is not in general use in the Piedmont because its effects on soil erosion and water runoff in that area have not been determined. These are some of the reasons why the use of fire cannot be generally prescribed. OBVIOUSLY ANY LANDOWNER CONSIDERING SOME PRESCRIBED BURNING SHOULD SEEK THE TECHNICAL ADVICE OF FORESTERS BEFORE PROCEEDING FURTHER.

In the Coastal Plain it is used for hazard reduction, the control of undesirable hardwoods and brush, and to prepare the seedbed for natural re-

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Figure 18.—A program of prescribed burning has effectively reduced hardwood understory and prepared the seedbed. *A*, Before management. *B*, After two improvement cuttings and several prescribed burns, the stand is in an ideal condition for natural regeneration.

seeding. Obviously, fire is best suited to the development and treatment of even-aged stands. During the life of a stand a complete program of prescribed burning will seldom require more than 8 or 10 fires. Annual fires are unnecessary and undesirable. Hardwood and brush control usually can be done with fires spaced 5–10 years apart. These should suffice to keep the hardwoods small, or controllable, to the point where adequate reseeding may be obtained with a single fire at the time of harvest (fig. 18).

In general, burning for hazard reduction and hardwood control in immature stands is done in the winter or dormant season. The purpose of the first fire is primarily to reduce the quantity of fuel and thereby help protect young saplings from ever-dangerous wildfire. This is usually done with a light backfire burning into a gentle but steady wind on the coolest days and when the soil is moist and the dead fuel is not completely dried out. Prescribed burning in loblolly pine is seldom done before the 15th year, usually the age when bark is thick enough and the trees tall enough to escape serious damage from light fires.

As the stand grows older and more open, the need for understory hardwood control usually increases and hazard reduction becomes less important. Thicker bark and higher crowns then make the pines more resistant to fire damage. Sooner or later it may be possible to burn with the wind but one must remember that headfires are more dangerous than backfires. Consequently, they should be used only where control can be assured. Headfires will tend to decrease the cost of prescribed burning and control somewhat larger hardwoods.

On the average, winter fires will kill back all brush and hardwood stems up to about 1 inch in diameter at breast height and many up to 2 inches in diameter. Larger hardwoods usually require treatments other than fire. Thus, stem diameter is a clue to when a fire is in order. However, very few hardwoods are killed outright by the winter fire, and practically all will resprout.

Seedbed preparation for natural regeneration (reseeding) can be done most effectively with a fire before logging. Fires after logging are much more difficult to handle and may injure or kill many seed trees. A prelogging fire also makes marking, felling, and bucking easier and fewer logs get lost in the brush. Any trees killed by the fire may be salvaged if harvesting closely follows the fire. The best time to burn is from June 1 to October 1, completing the job before seedfall begins but late enough in the growing season so resprouting hardwoods will not take over before pine seedlings can get started.

The responsibility for prescribed burning rests mainly with the property owner. Therefore, it is important that, before any attempt to prescribe burn is made, each landowner become informed as to the legal restrictions governing the use of fire in his locality. Remember, one man's prescribed fire may be another's wildfire if it escapes firelines or property lines.

APPENDIX

For those who may want to estimate merchantable volume in trees or logs, there follows a set of tables giving board-foot volume for trees and logs, and cordwood volume for trees and tops. The cordwood volumes are in terms of standard cords (4 by 4 by 8 feet). The board-foot volumes are based on the International one-fourth-inch rule, which closely approximates the rough green lumber contents of trees or logs. A topwood cordwood volume table is also included in view of the increasing utilization of the tops of sawtimber trees for pulpwood. To apply this table, it is necessary to establish limits of utilization for the top of the sawlog section as well as the top of the pulpwood section above.

TABLE 5.—*Average board-foot volume in loblolly pine trees of different total heights, utilized to a fixed top diameter of 5 inches inside the bark, International ¼-inch rule* [1]

Diameter breast high (inches)	Total height in feet							
	40	50	60	70	80	90	100	110
	Bd.-ft.	*Bd.-ft.*	*Bd.-ft.*	*Bd.-ft.*	*Bd.-ft.*	*Bd.-ft.*	*Bd.-ft.*	*Bd.-ft.*
8	18	24	29	36	45	55	63	.....
9	24	31	40	49	62	75	89	.....
10	.....	40	53	65	83	100	118	.....
11	.....	.....	69	85	108	129	150	.....
12	.....	.....	87	108	135	160	187	217
13	.....	.....	107	130	163	194	228	262
14	.....	.....	129	156	193	229	270	308
15	.....	.....	151	182	224	267	313	355
16	.....	.....	.....	205	255	306	357	404
17	.....	.....	.....	232	290	348	404	456
18	.....	.....	.....	260	325	391	452	510
19	.....	.....	.....	290	362	434	502	569
20	.....	.....	.....	320	400	480	556	627
21	.....	.....	.....	351	440	527	611	688
22	.....	.....	.....	384	480	576	669	750
23	.....	.....	.....	417	522	629	727	814
24	.....	.....	.....	452	567	681	786	878
25	.....	.....	.....	486	613	733	846	945
26	.....	.....	.....	521	658	787	906	1,010

[1] Derived from table 5 of *Volume, Yield and Stand Tables for Second-Growth Southern Pines.* U. S. Dept. Agr. Misc. Pub. 50, 202 pp. 1929.

TABLE 6.—*Contents of logs, in board-feet International ¼-inch log rule* [1]

Diameter of log at small end inside bark (inches)	Log length in feet						
	8	10	12	14	16	18	20
	Bd.-ft.	*Bd.-ft.*	*Bd.-ft.*	*Bd.-ft.*	*Bd.-ft.*	*Bd.-ft.*	*Bd.-ft.*
6	10	10	15	15	20	25	25
7	10	15	20	25	30	35	40
8	15	20	25	35	40	45	50
9	20	30	35	45	50	60	70
10	30	35	45	55	65	75	85
11	35	45	55	70	80	95	105
12	45	55	70	85	95	110	125
13	55	70	85	100	115	135	150
14	65	80	100	115	135	155	175
15	75	95	115	135	160	180	205
16	85	110	130	155	180	205	235
17	95	125	150	180	205	235	265
18	110	140	170	200	230	265	300
19	125	155	190	225	260	300	335
20	135	175	210	250	290	330	370

[1] From table 27 of *Converting Factors and Tables of Equivalents Used in Forestry.* U. S. Dept. Agr. Misc. Pub. 225, 48 pp. 1949.

TABLE 7.—*Average volume in standard cords in loblolly pine trees of different total heights, utilized to a fixed top diameter of 3 inches inside bark* [1]

Diameter breast high (inches)	Total height in feet							
	30	40	50	60	70	80	90	100
	Cords	*Cords*	*Cords*	*Cords*	*Cords*	*Cords*	*Cords*	*Cords*
4	0.0090	0.0140	0.0190	0.0238	0.0279	.....	.....	.....
5	.0158	.0240	.0304	.0368	.0427	0.0484	.....	.....
6	.0235	.0341	.0445	.0531	.0615	.0690	0.0769	.....
7	.0342	.0474	.0609	.0727	.0846	.0950	.1050	0.118
8	.0445	.0620	.0799	.0960	.113	.128	.143	.158
9	.0575	.0794	.102	.124	.144	.163	.183	.204
10	.0715	.0994	.127	.151	.177	.201	.226	.255
11	.....	.122	.154	.184	.215	.244	.276	.310
12	.....	.147	.183	.219	.258	.290	.330	.370
13	.....	.....	.217	.257	.302	.342	.390	.433
14	.....	.....	.252	.300	.350	.398	.451	.502
15	.....	.....	.290	.347	.401	.459	.519	.572
16	.....	.....	.329	.395	.454	.520	.589	.647
17	.....	.....	.....	.445	.510	.588	.660	.727
18	.....	.....	.....	.495	.568	.655	.734	.810
19	.....	.....	.....	.545	.628	.721	.810	.892
20	.....	.....	.....	.598	.691	.788	.886	.975

[1] Derived from table 3 of *Volume, Yield and Stand Tables for Second-Growth Southern Pines.* U. S. Dept. Agr. Misc. Pub. 50, 202 pp. 1929.

TABLE 8.—*Average volume in standard cords in tops of loblolly pine sawtimber trees by various limits of utilization, according to tree diameter class* [1]

Top diameter inside bark [2]		Tree diameter outside bark at breast height, in inches					
Sawlog section	Topwood section	10	12	14	16	18	20
Inches	*Inches*	*Cords*	*Cords*	*Cords*	*Cords*	*Cords*	*Cords*
6	4	0.035	0.025	0.018	.....	.....	.....
6	5	.028	.017	.012	.....	.....	.....
8	4	.120	.089	.071	.....	.....	.....
8	5	.109	.080	.058	0.045	0.035	0.032
8	6	.....	.....	.....	.034	.026	.025
10	5	.....	.....	.....	.125	.095	.077
10	6	.....	.....	.....	.112	.082	.066

[1] Derived from table 1 of *Loblolly Pine Topwood Volumes* by T. A. McClay, Southeastern Forest Experiment Station, Research Note No. 61. 1954.

[2] At top of utilized sections.

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